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LISTS OF SPECIES

Non-volant mammals, Parque Nacional do Catimbau, Vale do Catimbau, Buíque, state of Pernambuco, Brazil, with karyologic data

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ABSTRACT: We report the results of a terrestrial small mammal survey at one National Park in the northeastern Brazil, in the state of Pernambuco. The Catimbau National Park is located within the Caatinga domain with the characteristic thorn scrub vegetation. Our sampling encompasses several different vegetation/habitat types within the park area. All specimens collected were prepared as vouchers to be deposited in the Museu de Zoologia da Universidade de São Paulo. Karyotypes were obtained for all representative purported species collected. We report here the results of this first survey – two species of marsupials and seven of rodents - and added new occurrence localities for several small mammal species of this region, provide karyotypic information and register an undescribed species of arboreal rat of the genus *Rhipidomys*. This survey illustrates the need for extensive and planned sampling of the Caatinga domain.

INTRODUCTION

The Caatinga is the only biome fully within the Brazilian territory, with an extension of ca. 735,000 km^2, located mainly in northeastern Brazil. It is characterized by its xerophytic, deciduous vegetation, which is directly related to its extreme climatic variables, such as intense solar radiation, low nebulosity, high mean annual temperatures, and mainly low, irregular, and highly concentrated precipitation levels (Prado 2003; Leal *et al.* 2005).

Early studies based on some Caatinga localities suggested that its mammal fauna is poor, with a single endemic species, the caviid rodent *Kerodon rupestris* (Willig and Mares 1989). However, subsequent works, including taxonomic revisions or analyses using cytogenetic or molecular tools, are showing increasing levels of endemism in a previously unnoticed fauna. Endemic Caatinga mammals now include the sigmodontine rodent *Wiedomys pyrrhorhinus* (Gonçalves *et al.* 2005), a recently described phyllostomid bat, *Xeronycteris vieirai* (Gregorin and Ditchfield 2005), and species with very restricted distributions within the Caatinga such as the echimyid rodent *Trinomys yonenagae* (Rocha 1995), and the sigmodontine *Rhipidomys cariri*, that did not occur in the Caatinga, but isolated in the "brejos" (Tribe 2005). As a whole, Oliveira (2003) have recognized up to 19 mammal taxa that could be considered endemic or with most of their distribution within the Caatinga.

Our current knowledge of Caatinga mammals is restricted to a few localities. Large series of small mammals were collected in some localities, through the cooperation between the "Serviço Nacional de Peste" (SNP - National Plague Service) and the Museu Nacional, where they are now housed, thanks to efforts of Dr. João Moojen (Oliveira and Franco 2005). Some localities in the Chapada do Araripe region were also studied by a team from the Carnegie Museum of Natural History (Willig and Mares 1989; Oliveira *et al.* 2003), while more recent surveys have focused mainly in the humid enclaves called "Brejos de Altitude" (Sousa *et al.* 2004). Thus, despite the volume of specimens collected, they come from a limited number of localities, and most of the Caatinga is still unknown regarding its mammals fauna diversity. As an example, bat records from the "Universidade Federal de Pernambuco" mammal collection indicate that only 13 % of the Pernambuco Caatinga municipalities have ever been sampled. Besides, only three of these localities have more than ten bat species recorded (Astúa and Guerra 2008).

Here we present the results of a non-volant small mammal survey conducted at the Parque Nacional do Catimbau (PARNA do Catimbau), Vale do Catimbau, Buíque, state of Pernambuco, Brazil, providing new and important data on this group for the Caatinga of Pernambuco.

MATERIALS AND METHODS

Study Site

The PARNA do Catimbau was created in 2002, being one of the seven National Parks that includes caatinga vegetation, and the only National Park in state of Pernambuco (excluding the marine National Park of Fernando de Noronha). With an extension of 62,554 ha,

the PARNA do Catimbau occupies part of Buíque, Ibimirim and Tupanatinga municipalities (Figure 1), situated in the transition between the "agreste" and the "sertão", in the São Francisco River basin.

The climate in the PARNA do Catimbau is semi-arid tropical, with annual median temperature of 23 °C, and annual median precipitation of 300 to 500 mm. Vegetation is typical of Caatinga, with high diversity of species and structure. However, the area also includes species from Cerrado, Rupestrian Fields, Atlantic Forest and Restinga along with those typical from the Caatinga (IBAMA 2007). Shrub trees characteristic to Chapada Diamantina rupestrian fields (state of Bahia) also occurs in that region, as well as some bromeliads, cacti and "babaçu", and "buriti" palm trees. The PARNA do Catimbau is also the second major archaeological site in Brazil, with rupestrian paintings and other human artifacts, dated from at least 6,000 years, and 30 registered archaeological sites (IBAMA 2007). Over 150 bird species are known for the Catimbau region. Among those, we can cite the goldfinch, endemic to Northeastern Brazil, the "maria-macambira", and the "picapauzinho", rare in the Northeast and endemic to the Caatinga.

Data Collection

Field work was carried out from March 5th to 11th 2007, in a rainy period, with full moon. The small mammals capture was accomplished with 223 live traps, 96 Sherman® (30.4 x 9.5 x 7.6 cm and 23 x 7.5 x 8.5 cm) and 77 Tomahawk® (40 x 12 x 12 cm), being set mainly on the ground, and on trees or bushes whenever possible. Traps were set in distinct lines named from A to H, separated according to available habitats, with trapping lines encompassing different microhabitats (Figures 1 and 2, Table 1). Used bait was banana/manioc/peanut butter. Trap lines were kept open during seven consecutive nights, with a total of 1,391 traps-nights effort, being checked every morning. Trapping was carried out with license number 02001.007214/2006-26 IBAMA.

Karyotypes from selected specimens were prepared in the field. Chromosomes in metaphases were obtained with *in vitro* culture (culture of bone marrow grown in Dulbecco´s MEM with 10 % fetal bovine serum and colchicine), following incubated in KCl 0.075M solution at 37 °C by 30 minutes, centrifuged, fixed in Carnoy solution (methanol: acetic acid, 3:1), dropped onto clean slides and air-dried. Conventional coloration with Giemsa 5 % was used to observe diploid (2n) and autosomal (NA, excluding sexual chromosomes) numbers and chromosome morphology variation. This analysis was carried out using an optic photomicroscope (Hund Wetzlar - H500 LL HP100 and Olympus BX 60), and karyotypes were set and compared with literature. Tissue (liver) samples were collected and fixed in 96 % ethanol. Ectoparasites were collected, while skins, skulls and partial skeletons were prepared as vouchers to be deposited in the "Museu de Zoologia da Universidade de São Paulo" (MZUSP) mammal collection.

Standard external measurements (millimeters) and weight (grams) were recorded for each specimen. Habitat data, coordinates and altitude were obtained for each capture line (Table 1). Sigmodontinae rodent specimens were also identified to species level by karyological analysis, as similar external morphologies occur among them (Geise *et al.* 2005). Morphological characters (skin and skull) were considered for species identification in comparison to previous descriptions for Didelphimorphia (Voss *et al.* 2005) and Rodentia (Bonvicino and Weksler 1998; Bonvicino *et al.* 2002; Gonçalves *et al.* 2005, Tribe 2005; Percequillo *et al.* 2008). The nomenclature follows Wilson and Reeder (2005) and Gardner (2007).

FIGURE 1. Location of PARNA do Catimbau, Vale do Catimbau, Buíque, state of Pernambuco, Brazil, and trap lines (for more information, see Table 1). Modified from IBAMA (2007).

RESULTS AND DISCUSSION

A total of 72 small mammal specimens from the orders Didelphimorphia (two genera and two species) and Rodentia (three families, seven genera and seven species) were collected.

Chromosome preparations were obtained from 22 specimens, identified by a star (*), in the species account below. One female specimen of *Mus musculus* was also trapped, near a residence, not included in the species account. F = females, M = males , and U = undetermined.

Order Didelphimorphia, Family Didelphidae, Subfamily Didelphinae

Gracilinanus agilis Burmeister, 1854 (Figure 3a)

Specimens account: (F – LEM 17*, 46*).

All captured with traps on trees in this survey.

Karyotype: Specimens karyologic analyses showed 2n = 14, NA = 20. The karyotype is similar to that described by Carvalho *et al.* (2002), but we are here considering the number of autosomal arms as 20, as both last pairs can not be considered as being subtelocentric according to our observation (Figure 4).

Monodelphis domestica (Wagner, 1842) (Figure 3b)

Specimens account: (F – LEM 5*, 21, 27, 28, 55, 57, 61, 69, 81), (M – LEM 4*, 14, 15*, 16, 25, 26, 29, 30, 40, 44, 53, 54, 56, 67, 68, 70, 71, 76).

All captured with traps on the ground in this survey.

Reproduction: three females had youngs attached to the teats, one with 11 and two with nine.

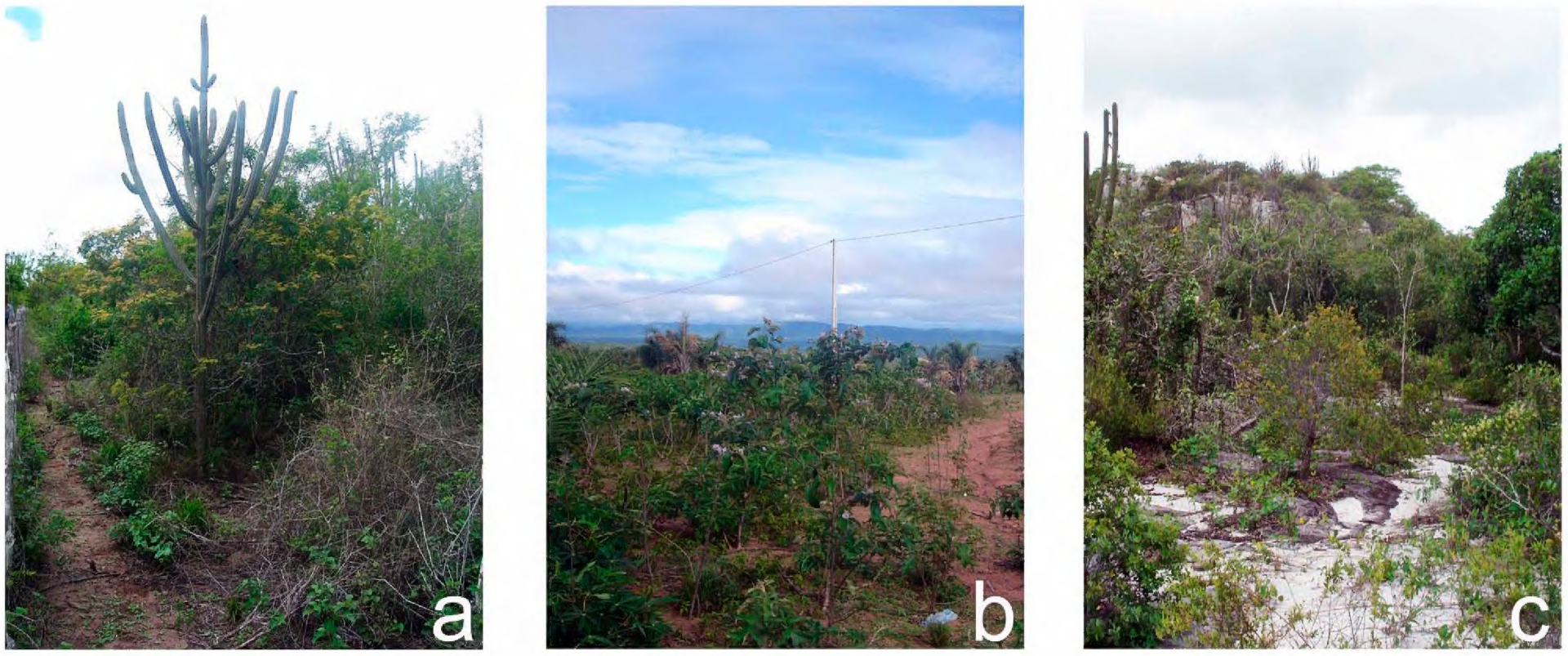

Figure 2. Representatives of some vegetation types from the PARNA do Catimbau surveyed during field work: a) Trap lines A and B; b) Trap line C; c) Trap line D; d) Trap line E; e) Trap line F; f) Trap line G. Photos by Diego Astúa (c), Leila T. Shirai (d) and Roberta Paresque (a, b, e and f). Vegetation types are described in Table 1 for each line.

Table 1. Vegetation types with mammal species recorded in the study site and detailed information for each trapping line.

Trap line	Vegetation type	Period	# of traps	# trapping nights	Coordinates and altitude	Species collected
A	*Macambira de boi* and *croatá* (Bromeliaceae), and high plants, mainly cactus (Figure 2a).	4-8 March	50	4	8°30'29.9"S, 37°16'51.1" W 950 m	none
B	*Macambira de boi* and *croatá* (Bromeliaceae), and high plants, with many cactus (Figure 2a).	4-8 March	10	4	8°30'29.9"S, 37°16'51.1" W 950 m	*Monodelphis domestica, Gracilinanus agilis*
C	Close to a rural house, open field vegetation with some sparse trees, mainly the *coco curicuri* palm tree (Figure 2b).	4-10 March	28	7	8°31'25"S, 37°14'24.5"W 952 m	*Cerradomys langguthi, Necromys lasiurus, Mus musculus*
D	Known as *Trilha Chapadão* – Serrinha: rupestrian field, with some sparse trees and bushes. White sandy soil (Figure 2c).	4-10 March	40	7	8°31'25"S, 37°14'24.5"W 952 m	*M. domestica, C. langguthi*
E	Known as *Trilha do Pinga*, in a more humid area, along a dry seasonal river bed. Wet Forest vegetation, with many rocks (Figure 2d).	4-10 March	35	7	8°34'53.8"S, 37°14'29.2"W 972 m	*M. domestica, G. agilis, C. langguthi, Oligoryzomys stramineus, Thricomys laurentius, Rhipidomys* sp.
F	Known as *Trilha Cemitério*, with a similar vegetation to Line E (Figure 2e).	4-10 March	30	7	8°34'53.8"S, 37°14'29.2"W 972 m	*M. domestica, O. stramineus, Wiedomys pyrrhorhinos, T. laurentius, Galea spixii*
G	Bush vegetation (Figure 2f).	4-10 March	40	7	8°31'25"S, 37°14'24.5"W 952 m	*M. domestica, C. langguthi, N. lasiurus,*
H	Dense caatinga vegetation, with shrubs and trees dominating.	9-10 March	50	7	8°30'29.9"S 37°16'51.1" W 946 m	*M. domestica, C. langguthi, W. pyrrhorhinos, G. spixii*

Karyotype: The karyotyped individuals showed a 2n = 18, NA = 22 (Figure 5), corresponding to the already described karyotype by Carvalho *et al.* (2002) and Pereira and Geise (2007), comprising three pairs of biarmed and five pairs of acrocentric chromosomes. Variation in the NAs is frequent for the species, as reported by Svartman and Vianna-Morgante (1998), showing a variation from NA = 20 in specimens from state of Goiás (Pereira *et al.*, 2008), NA = 24 in Bolívia (Carvalho *et al.* 2002), NA = 28 also in state of Goiás (Carvalho *et al.* 2002) and NA = 30, registered in state of Espírito Santo (Paresque *et al.* 2004).

Monodelphis domestica is one of the most widely distributed species in xeric vegetation formation of this genus. Karyotypic diversity in different geographic areas possibly indicates more than one species, further analyses being necessary.

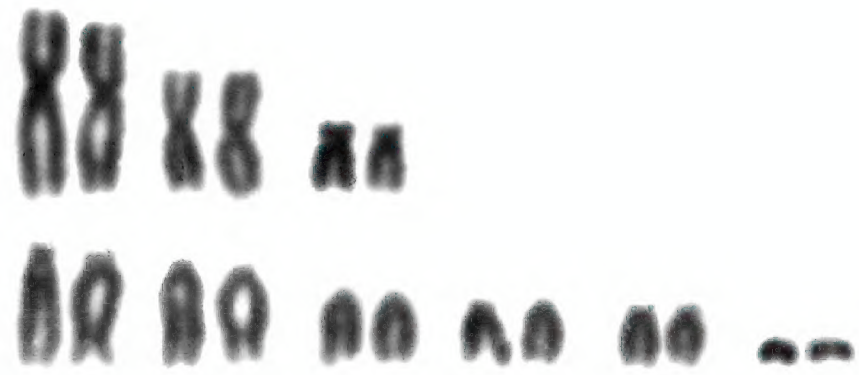

FIGURE 5. Karyotype of *Monodelphis domestica* (LEM 5), with conventional staining.

FIGURE 3. Pictures of small mammals of the PARNA do Catimbau: a) *Gracilinanus agilis* (LEM 17); b) *Monodelphis domestica* (LEM 5); c) *Cerradomys langguthi* (LEM80); d) *Oligoryzomys stramineus* (LEM 13); e) *Wiedomys pyrrhorhinos* (LEM 63); f) *Rhipidomys* sp. (LEM 20); g) *Galea spixii* (LEM 65) and h) *Thrichomys laurentius* (LEM 36). Photos by Leila T. Shirai and Roberta Paresque (a, b, d, f, h) and Diego Astúa (c, e, g).

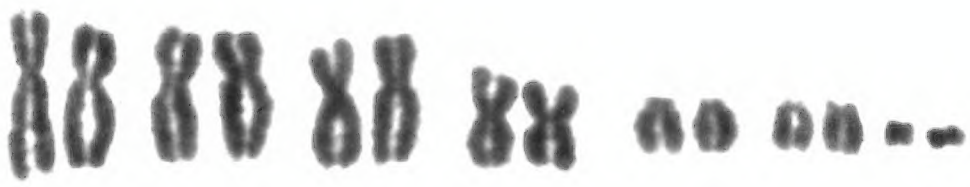

FIGURE 4. Karyotype of *Gracilinanus agilis* (LEM 17), with conventional staining.

Order Rodentia, Suborder Myomorpha, Superfamily Muroidea, Family Cricetidae, Subfamily Sigmodontinae

Cerradomys langguthi Percequillo, Hingst-Zaher and Bonvicino, 2008 (Figure 3c)

Specimens account: (I – LEM 79); (F – LEM 19, 23, 35*, 45, 49*, 50*, 51, and 80); (M – LEM 2*, 3*, 6*, 9*, and 10*).

All specimens were captured on the ground.

Reproduction: three pregnant females were found, one with two and two with six embryos. One female was found with the vagina open.

Karyotype: Karyologic analyses of eight specimens (five males and three females) showed 2n = 48/49/50, NA = 56 (Figure 6), a chromosome complement similar to the one originally described for this species (Percequillo *et al.* 2008), with the variation found by us being in accordance to those described by Maia and Hulak (1981) and Bonvicino (2003). According to Percequillo *et al.* (2008), variation in diploid number is due to centric fusion affecting two acrocentric pairs. The sample analyzed by Maia and Hulak (1981) includes the area sampled by us and the karyotypes are similar.

The type locality is "Corredor São João, Fazenda Pacatuba", Sapé, state of Paraíba, in an Atlantic Forest remnant. Our specimens were collected in caatinga and forest remnants (Table 1). According to Percequillo *et al.* (2008), *C. langguthi* is distributed on the left bank of Rio São Francisco, being registered until now, in the states of Pernambuco, Paraíba, Ceará, and Maranhão. In Pernambuco, Paraíba, and Ceará, records include areas at coastal lowlands, inland highlands and mountain ranges. In Maranhão the species occurrence is associated with lowlands in the central portion of the state. Our new records include also typical Caatinga vegetation to the species distributional pattern, extending the species distribution into another domain.

Necromys lasiurus (Lund, 1840)

Specimens account: (F – LEM 31, 32, 33, 34, 42, 43, 47, 58, 74), (M – LEM 18*, 41*, 48, 59, 66, 72, 77, 78).

All specimens were collected with traps on the ground.

Reproduction: four pregnant females were found, two with five and two with six embryos. One female gave birth to two young in the trap.

Karyotype: Karyologic analyses of two males showed

2n = 34, NA = 36, a chromosome complement similar to that described for this species (Yonenaga 1975; Kasahara and Yonenaga-Yassuda 1983; Fagundes and Yonenaga-Yassuda 1998), comprising 15 acrocentric pairs (large to small) and one small metacentric pair. The X chromosome is a medium acrocentric and the Y is a small acrocentric, only perfectly identified by G-banding technique. The karyotype of *N. lasiurus* is mostly constant for diploid and autosomal arms number, but variation in diploid number can occur (Maia and Langguth 1987; Svartman and Almeida 1993; Fagundes and Yonenaga-Yassuda 1998) due to a heterozygous Robertsonian rearrangement or simple centric fusion, resulting in 2n = 33.

The type locality is in Lagoa Santa, Rio das Velhas, state of Minas Gerais, and according to Hershkovitz (1962), it may occur in many habitats south to the Amazon domain, distributed in central and eastern area of South America (Macêdo and Mares 1987), occurring mainly in the Cerrado and Caatinga. In northeastern Brazil, it is mainly registered in cultivated or abandoned plantation fields (Streilein 1982). According to Reig (1987), the distribution extends from the states of Pará to São Paulo. It is not considered as a species endemic to the Cerrado and Caatinga anymore, being commonly trapped in the Atlantic Forest (D'Andrea *et al.* 2007; D'Elia *et al.* 2007).

Oligoryzomys stramineus Bonvicino and Weksler 1998 (Figure 3d)

Specimens account: (F – LEM 13*, 24*), (M – LEM 12*)
All captured with traps on the ground.

Reproduction: one pregnant female was found. As our field trip occurred in March, during the rainy season, reproduction is occurring in a different season than reported by Weksler and Bonvicino (2005) who found young juveniles in August and a pregnant female in September.

Karyotype: Karyologic analyses of three individuals showed 2n = 52, NA = 68 (Figure 7), a chromosome complement similar to that described for this species (Bonvicino and Weksler 1998; Andrades-Miranda *et al.* 2001; Weksler and Bonvicino 2005), as number of autossomal arms ranges from 68 to 70. The karyotype here reported is composed by nine biarmed and 16 acrocentric autosome pairs. The X chromosome is a medium to large biarmed and the Y a medium metacentric chromosome.

The type locality is in Teresina de Goiás, Fazenda Vão dos Bois, in state of Goiás. Other specimens were already reported from Minas Gerais, Paraíba and Pernambuco states (Andrades-Miranda *et al.* 2001; Weksler and Bonvicino 2005), corresponding to localities in Cerrado and Caatinga formations. The four specimens here reported were trapped in typical high elevation Caatinga (Table 1).

FIGURE 6. Karyotypes of *Cerradomys langguthi* (conventional staining). a - male individual with 2n=48 (LEM 9). b - male individual with 2n = 49 (LEM 6), heteromorphic pair constituted by acrocentric chromosomes seven and nine and submetacentric chromosome. c - male individual with 2n = 50 (LEM 1778), pair seven and nine are acrocentrics.

Wiedomys pyrrhorhinos (Wied-Neuwied 1821) (Figure 3e)

Specimens account: (F – LEM 63*), (M – LEM 75*).

Reproduction: the captured female was pregnant, with five embryos.

Karyotype: Karyologic analyses of two trapped individuals showed 2n = 62, NA = 86, a chromosome complement already described for this species (Maia and Langguth 1987; Pereira and Geise 2007), and different from those described by Gonçalves *et al.* (2005). The autosomal complement consists of 13 pairs of biarmed and 17 pairs of acrocentric chromosomes, varying from medium to small. The X chromosome corresponds to the largest acrocentric autosome in size while the Y is a small one.

The two species of the genus, *Wiedomys pyrrhorhinos* and *W. cerradensis*, are widely distributed in the Brazil dry vegetation formations, being more frequently captured during dry periods in the caatinga of Bahia, mainly in the "serra", which are areas of caatinga with exposed rock and low litter contribution (Freitas *et al.* 2005; Gonçalves *et al.* 2005). In Chapada Diamantina, individuals were also captured in rocky savannas (Freitas *et al.* 2005 and L. Geise personal observation), as reported here.

Rhipidomys sp. (Figure 3f)

Specimens account: (F – LEM 22*).

Karyotype: Karyologic analyses showed 2n = 44, NA = 50, the autosomal complement composed of 17 acrocentric pairs with gradual variation of size and four biarmed pairs with gradual variation of size. The X chromosome is a large submetacentric and the Y is a midle acrocentric (Figure 8), a similar karyotype to that described by Zanquin *et al.* (1992) and Pereira *et al.* (2001). Ongoing morphological analyses of the skull and from the prepared skin carried out by Bárbara M. de Andrade Costa (personal communication) showed that this specimen does not correspond to any species of the genus, even presenting the same diploid and autosomal numbers as another

undescribed species (Zanquin *et al.* 1992; Pereira *et al.* 2001). Further collecting effort is necessary in this region to allow a more precise taxonomic consideration.

Order Rodentia, Suborder Hystricomorpha, Family Caviidae, Subfamily Caviinae

Galea spixii - (Wagler, 1831) (Figure 3g)

Specimens account: (F – LEM 65), (M – LEM 64).

Specimens were all captured on the ground.

According to Eisenberg and Redford (1999) and Woods and Kilpatrick (2005), the distribution goes from eastern part of Bolivia to northeastern Brazil, so our registers are in accordance to the known distribution of the species. The type locality is restricted to Lagoa Santa, state of Minas Gerais, Brazil. No karyological data could be obtained from these specimens.

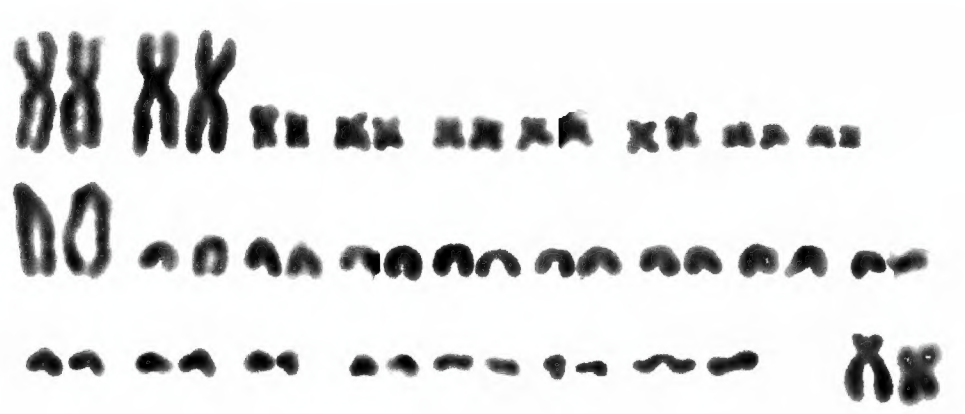

Figure 7. Karyotype of *Oligoryzomys stramineus* (LEM 12), with conventional staining.

Figure 8. Karyotype of *Rhipidomys* sp. (LEM 22), with conventional staining.

Order Rodentia, Suborder Hystricomorpha, Family Echimyidae, Subfamily Eumysopinae

Thrichomys laurentius (Thomas 1904) (Figure 3h)

Specimens account: (F – LEM 7, 11*, 36, and 73).

Reproduction: Two pregnant females were captured, with one and two embryos.

Karyotype: Karyologic analyses showed 2n = 30, NA = 54, a chromosome complement similar to that described for this species (Bonvicino *et al.* 2002). The autosomic complement is formed by 13 pairs of biarmed chromosomes and one large subtelocentric, the first pair showing the characteristic secondary constriction region on the short arms. The X chromosome is a medium-sized acrocentric and the Y a small-sized submetacentric.

The species has been reported for the Brazilian northeast, excluding the Atlantic Forest coastal belt. Karyotypes were obtained for specimens from Bahia (Bonvicino *et al.* 2002), Pernambuco (Souza and Yonenaga-Yassuda 1982), Piauí, and Ceará (Bonvicino *et al.* 2002), surrounding the *T. inermis* distribution, a species restricted to the Chapada Diamantina region and their surroundings (Bonvicino *et al.* 2002; Pereira and Geise 2007).

All results here reported, despite the briefness of this survey, show how poorly known is the non-volant small mammal fauna from the Caatinga. A new karyotypic form was found for *Rhipidomys*, probably corresponding to an undescribed species, deserving more trapping effort. New chromosomal polymorphism found in the sample of *M. domestica* and *C. langguthi* increased the knowledge of these two species variation and highlight the need for more detailed systematic reviews of these taxa. Being the only Pernambuco Caatinga federally protected area, the PARNA do Catimbau is an important area for long term studies, contributing also to unravel the poorly known Caatinga diversity.

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